Having fully described the invention, the following is claimed:

1. An apparatus for correcting optical aberrations of a patient's eye, said apparatus comprising:

a laser for performing ablation to modify the optical aberrations of the patient's eye; and

control means for controlling ablation by said laser in accordance with a control algorithm that corrects the optical aberrations and further corrects for predicted induced aberrations.

2. The apparatus of claim 1 wherein said control means includes means for storing a mathematical model that predicts the induced aberrations resulting from surface smoothing, said control means controlling said laser ablation to correct existing refractive error and aberration plus induced aberration predicted by the mathematical model.

3. The apparatus of claim 2 wherein said mathematical model is determined using a convolution operation in a spatial domain on an ablation map with a

smoothing function, said mathematical model predicting the surface smoothing affect.

4. The apparatus of claim 3 wherein the smoothing function is the impulse function of a corneal surface of the patient's eye.

5. The apparatus of claim 4 wherein the mathematical model determines a corneal surface height change $\Delta h(x',y')$ in the spatial domain according to

$$\Delta h'(x',y') = a'(x',y') \otimes f'(x',y')$$

where

$\Delta h'(x',y')$ is the corneal surface height change in local coordinates,

$a'(x',y')$ is the ablation map in local coordinates, and

$f'(x',y')$ is the impulse response function of the corneal surface.

6. The apparatus of claim 2 wherein said mathematical model is determined using a multiplication operation in a frequency domain on an ablation map with a frequency response of the corneal surface having a smoothing function constant that characterizes the

surface smoothing, said mathematical model predicting the surface smoothing affect.

7. The apparatus of claim 6 wherein the mathematical model determines a corneal surface height change ΔH in a frequency domain according to

$$\Delta H'(\omega_x', \omega_y') = A'(\omega_x', \omega_y')\ F'(\omega_x', \omega_y')$$

where

$\Delta H'(\omega_x', \omega_y')$ is the Fourier transform of a corneal surface height change $\Delta h'(x',y')$ in local coordinates,

ω_x' and ω_y' are the respective spatial frequencies for x' and y' in radians/length,

$A'(\omega_x', \omega_y')$ is the Fourier transform of $a'(x',y')$,

$F'(\omega_x', \omega_y')$ is the frequency response of the corneal surface.

8. The apparatus of claim 7 wherein the frequency response of the corneal surface is determined by

$$F'(\omega_x', \omega_y') = 1/[1+ s^2\ (\omega_x'^2 + \omega_y'^2)]$$

where

s is a smoothing constant that characterizes the epithelial smoothing model.

9. The apparatus of claim 2 wherein said controller includes means for performing an iterative deconvolution algorithm to generate an ablation pattern that compensates for the induced aberrations.

10. The apparatus of claim 9 wherein said control algorithm provides a transition zone around an optical zone in accordance with a cubic spline function for providing continuity in ablation depth and slope.

11. The apparatus of claim 1 wherein said control means includes means for storing a rain-drop algorithm to control pulse placement of said laser during ablation.

12. A method for modifying optical refraction of a patient's eye comprising the steps of:

providing a vision correction laser to modify refraction of the patient's eye; and

controlling ablation by said laser in accordance with a control algorithm that corrects for existing measured aberrations and anticipates and corrects for induced aberrations.

13. The method of claim 12 wherein said step of controlling ablation includes determining a correction map in response to the existing measurements, storing a mathematical model that predicts corneal surface smoothing responsive to laser ablation, and determining an ablation map in response to the mathematical model.

14. The method of claim 13 wherein said step of determining the ablation map further includes generating ablation patterns using an iterative deconvolution algorithm that adjusts for a predicted smoothing response to said ablation.

15. The method of claim 12 wherein said step of controlling further includes the step using a rain-drop algorithm to control pulse placement of said laser to control ablation.

16. A method for correcting optical aberrations comprising the steps of:

providing a computer controlled ablation device for ablating a patient's eye;

performing pre-operative optical measurements to establish a corrective prescription;

establishing a mathematical model to predict surface smoothing;

establishing an ablation map based on the corrective prescription and the mathematical model; and

ablating the patient's eye with the ablation device in accordance with the ablation map.

17. The method of claim 16 wherein the step of establishing the ablation map includes establishing a transition zone based on a cubic spline function.

18. The method of claim 16 wherein the step of establishing a mathematical model includes convolving an initial ablation map with a surface smoothing function.

19. The method of claim 18 wherein the step of establishing the ablation map further includes performing an iterative deconvolution on the mathematical model.

20. The method of claim 16 further including the step of establishing a pulse sequence for the ablation device based on a rain drop algorithm.

21. A computer program product operative in a laser surgical device for correcting optical aberrations, the computer program product comprising:

a correction mapping stage that determines a correction map based on optical measurements;

an ablation mapping stage that uses a mathematical model to predict induced aberrations and adjusts the correction map for predicted induced aberrations from the mathematical model; and

a pulse control stage to optimize placement of pulses in accordance with the ablation map.

22. The computer program product of claim 21 wherein said ablation mapping stage stores the mathematical model that predicts the induced aberrations resulting from surface smoothing and wherein said pulse control stag is operative to control laser ablation to correct existing refractive error and aberration plus induced aberration predicted by the mathematical model.

23. The computer program product of claim 22 wherein said mathematical model used in the ablation

mapping stage is determined using a convolution operation in a spatial domain on the ablation map with a smoothing function, said mathematical model being operative to predict the surface smoothing affect.

24. The computer program product of claim 23 wherein the smoothing function is the impulse function of a corneal surface of the patient's eye.

25. The computer program product of claim 24 wherein the mathematical model is operative to determine a corneal surface height change $\Delta h(x', y')$ in the spatial domain according to

$$\Delta h'(x',y') = a'(x',y') \otimes f'(x',y')$$

where

$\Delta h'(x', y')$ is the corneal surface height change in local coordinates,

$a'(x', y')$ is the ablation map in local coordinates, and

$f'(x', y')$ is the impulse response function of the corneal surface.

26. The computer program product of claim 22 wherein said mathematical model is determined using a

multiplication operation in a frequency domain on an ablation map with a frequency response of the corneal surface having a smoothing function constant that characterizes the surface smoothing, said mathematical model being operative to predict the surface smoothing affect.

27. The computer program product of claim 26 wherein the mathematical model is operative to determine a corneal surface height change ΔH in a frequency domain according to

$$\Delta H'(\omega_x', \omega_y') = A'(\omega_x', \omega_y')\ F'(\omega_x', \omega_y')$$

where

$\Delta H'(\omega_x', \omega_y')$ is the Fourier transform of a corneal surface height change $\Delta h'(x', y')$ in local coordinates,

ω_x' and ω_y' are the respective spatial frequencies for x' and y' in radians/length,

$A'(\omega_x', \omega_y')$ is the Fourier transform of $a'(x', y')$,

$F'(\omega_x', \omega_y')$ is the frequency response of the corneal surface.

28. The computer program product of claim 27 wherein the frequency response of the corneal surface is determined by

$$F'(\omega_x', \omega_y') = 1/[1+ s^2 (\omega_x'^2 + \omega_y'^2)]$$

where

s is a smoothing constant that characterizes the epithelial smoothing model.

29. The computer program product of claim 22 wherein said ablation mapping stage is operative to perform an iterative deconvolution algorithm to generate an ablation pattern that compensates for the induced aberrations.

30. The computer program product of claim 29 wherein said ablation mapping stage provides a transition zone around an optical zone in accordance with a cubic spline function for providing continuity in ablation depth and slope.

31. The computer program product of claim 21 wherein said pulse control stage uses a rain-drop algorithm to control pulse placement during ablation.